

**CLINAL VARIATION IN FEMALE *HYPOLYCAENA PHORBAS PHORBAS* (FABRICIUS) (LEPIDOPTERA: LYCAENIDAE) AND REVISION OF THE STATUS OF *H. P. INGURA* TINDALE**

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**Abstract**

*Hypolycaena phorbis* (Fabricius) from Queensland and the Northern Territory is reviewed. Females were found to form a cline in Queensland, with predominantly pale forms occurring in the south, progressing to mostly dark forms at the northern extremity of its range. This trend was found to be unrelated to season. Dark specimens from the northern Torres Strait islands were found not to differ from specimens from the Northern Territory and northern Western Australia, and further evidence is provided to place *H. p. ingura* Tindale as a junior synonym (syn. n.) of *H. p. phorbis*. There is no evidence to indicate that variation in males is also clinal, with male variations found to occur randomly throughout the range of *H. p. phorbis*. The current known distribution of the species in Torres Strait is summarised.

**Introduction**

Within Australia, *Hypolycaena phorbis* (Fabricius) occurs in a variety of coastal and subcoastal habitats, extending from the Mitchell Plateau in Western Australia, through the northern part of the Northern Territory and into Queensland, including the northern Torres Strait islands (Braby 2000, Lambkin *et al.* 2005), the west coast of Cape York Peninsula (Hancock and Monteith 2004) and the east coast from Cape York to Tannum Sands, just south of Gladstone (Braby 2000). Two subspecies are recognized from Australia; *H. p. phorbis* (Fabricius) is known from tropical Queensland, while *H. p. ingura* Tindale is recorded from northern Western Australia and northern areas of the Northern Territory (Braby 2000). The two subspecies are distinguished primarily on the basis of the size of the central cream-coloured patch on the upperside of the forewing in females. In *H. p. ingura* this white patch is normally much less prominent and covered with blue-grey scales, or sometimes absent (Tindale 1923, Braby 2000).

Prior to the mid 1970s, almost all known specimens of *H. p. phorbis* were from mainland Queensland, south of Cape York Peninsula, and its coastal islands (Braby 2000), with a relatively small number known north of Cooktown (Waterhouse and Lyell 1914). Since then, more systematic collecting of butterflies on Cape York Peninsula and in Torres Strait has been undertaken, with many more specimens of *H. p. phorbis* now known from Cape York Peninsula and many of the Torres Strait island groups (Braby 2000). In general, specimens of *H. p. phorbis* from the more northern Torres Strait islands have been difficult to assign taxonomically (Braby 2000), a problem compounded by the existence of a similar species, *H. litoralis* Lambkin, Meyer, Brown & Weir, recently identified from the same islands (Lambkin *et al.* 2005). The upperside facies of male *H. p. phorbis* are also variable, with the upperside colouration of both wings varying from greenish-

blue to purple (Waterhouse and Lyell 1914), and with many specimens possessing a variable area of white scales on the forewing in the area below the sex brand, above vein 1A+2A. Braby (2000) reported that the upperside colour of males in the southern end of the species' range tended to be darker and duller blue. Parsons (1998) reported that both sexes of *H. phorbas silo* Fruhstorfer from Papua New Guinea were also variable, with some males also possessing white scales above vein 1A+2A.

An examination of specimens of both sexes of *H. p. phorbas* from Queensland has indicated that female specimens north of Cooktown are, like *H. p. ingura*, highly variable in the extent of the forewing cream patch, with many specimens indistinguishable from *H. p. ingura*. Males of *H. p. phorbas* are highly variable, even from the same geographical area, and therefore it is difficult to assign particular colour forms to geographical areas. However, in Queensland, the female variation appears to be clinal. In this paper, the variation in the external upperside facies of female *H. p. phorbas*, in particular the size and character of the central cream/bluish-grey patch of the forewing, is documented, illustrated and analysed to determine if this variation is clinal. Variation in males from Queensland and Northern Territory/Western Australia is also reviewed in order to determine if they form part of this cline. In light of the findings of this study, the status of *H. p. ingura* is revised. Abbreviations used for specimen depositories and collectors are listed in Appendix 1.

### Methods and materials

A microscopic examination of the forewing patches of female *H. phorbas* indicated that the patches consist of, when present, densely packed cream-coloured scales, overlaid with a variable number of much sparser greyish-blue scales. In this study, 318 females (Appendix 1) of *H. phorbas* from mainland Queensland, Torres Strait, Northern Territory and Western Australia were examined and, in general, almost all specimens could be placed into one of three morphological groups. These groups were categorised relative to the size and scale structure of the central forewing patch, and the prominence of subterminal rings and extent of white and bluish-grey scaling on the hindwing upperside. The specimens were further grouped relative to their collection sites and placed into four nominated geographical zones. The boundaries of these zones were designated to be locations where morphological characters appeared to change. Specimens within each morphological group from each geographical zone across the species' range were counted and compared in order to determine if the variation was clinal. As well, the month of capture for each specimen from each morphological group in each geographical zone was tabulated in order to detect any seasonal effect on morphology.

The morphological groups chosen (upperside of females) with distinguishing facies were:

*Morph group 1:* Forewing with extensive area of cream scales (greater than half the size of the patch), partly overlaid with a large area of dense bluish-grey scales. Hind wing with prominent white and bluish-grey scales and with prominent subterminal rings (Figs 1, 2).

*Morph group 2:* Forewing with restricted area of cream scales (less than half the size of the patch), overlaid totally with a much larger area of dense bluish-grey scales. Hind wing with reduced bluish-grey scales and with prominent subterminal rings (Figs 3, 4).

*Morph group 3:* Forewing without cream or bluish-grey scales or with only a dusting of scales. Hind wing without coloured scales and with white subterminal rings markedly reduced or blurred (Figs 5, 6).

Another morphological group was identified (Figs 7, 8), but it was not considered for the study as it was consistently rare across all geographical zones (between 3 and 6 specimens per zone), and had no bearing on the study. Its external facies were: forewing with large area of cream scales without bluish-grey scales; hind wing without coloured scales and with blurred subterminal rings.

The geographical zones designated across the species' range were: Zone A - coastal Queensland from Gladstone north to and including Cooktown; Zone B - coastal Queensland from north of Cooktown to and including the Thursday Island group of islands in Torres Strait, plus western Cape York Peninsula; Zone C - central, eastern and northern Torres Strait islands; Zone D - Northern Territory and northern Western Australia.

In addition, 123 males of *H. phorbis* (Appendix 2) from Queensland and the Northern Territory/Western Australia were firstly grouped into the four geographical zones. The specimens were then examined to determine if any morphological characters, such as the extent or type of upperside colouration, or the presence of white scales on the forewing in the area above vein 1A+2A, could be linked to the geographical zones.

## Results

The number of females in each morphological category from each geographical zone, and the percentage of each of the total, were grouped and tabulated, including months of capture for all specimens (Table 1). The majority of specimens (73.5%) from the most southern region (Zone A) had extensive areas of cream scales (morph group 1), with this feature progressively diminishing in specimens from Zone B (44.6% of specimens), to a very low frequency in the most northern regions (Zones C and D: 12.1% and 5.6% respectively). Inversely, the frequency of the two darker morph groups (2 and 3) progressively increased from south to north, to an extent that the majority of specimens north of Cooktown (Zones B, C and D) had generally dark upperside facies.



**Figs 1-8.** *Hypolycaena phorbis*, upperside of females. All figures to scale [forewing lengths in parentheses]: (1) Iron Range, Qld, 4-12.vii.1995, JWCD (ANIC) [18 mm]; (2) Thursday I., Qld, 23-30.vii.1983, TAL (TLIKC) [19 mm]; (3) Dauan I., Qld, 14.v.2001, AIK (TLIKC) [20 mm]; (4) Thursday I., 12.xii.1993, TAL (TLIKC) [19 mm]; (5) Dauan I., 28.i.2004, AIK (TLIKC) [20 mm]; (6) Darwin, NT, 1-22.iii.2003, RPW (TLIKC) [17 mm]; (7) Dauan I., 3.v.2001, AIK (TLIKC) [18 mm]; (8) Yorke I., Qld, 15.vi.1973, JWCD (ANIC) [17 mm].

**Figs 9-24.** *Hypolycaena phorbis*, upperside of males. All figures to scale [forewing lengths in parentheses]: (9) Dauan I., Qld, 21.iii.2004, TAL (TLIKC) [18 mm]; (10) Dauan I., 19.ii.2004, TAL (TLIKC) [17 mm]; (11) Dauan I., 21.ii.2004, TAL (TLIKC) [17 mm]; (12) Dauan I., 29.i.2004, AIK (TLIKC) [18 mm]; (13) Cape Wessell, NT, 26.vi.1973, JWCD (ANIC) [16.5 mm]; (14) East Point, Darwin, NT, 28.iv.-3.v.1993, AIK (TLIKC) [16 mm]; (15) Darwin, 1-22.iii.2003, RPW (TLIKC) [15 mm]; (16) Kalumburu, WA, 13.v.1991, JWCD (ANIC) [15 mm]; (17) Thursday I., Qld, 12-15.iv.1992, TAL (TLIKC) [15 mm]; (18) Cape York, Qld, 21.x.1979, JWCD (ANIC) [16 mm]; (19) Thursday I., 22.vi.1973, JWCD (ANIC) [17 mm]; (20) Thursday I., 23-31.vii.1983, TAL (TLIKC) [16 mm]; (21) Townsville, Qld, 20.xi.1984, PSV (TLIKC) [17 mm]; (22) Great Keppel I., Qld, 25.xii.2002, JSB (JSBC) [17 mm]; (23) Yeppoon, Qld, 3-4.i.1979, TAL (TLIKC) [19 mm]; (24) Allingham, Qld, 10.iii.1982, PW (DPIFC) [18 mm].



**Table 1.** Proportions and percentages of the three morph types of female *H. phorbas* (318 specimens) occurring in four designated geographical zones in Queensland, Northern Territory and northern Western Australia. Months of capture (i-xii) are indicated for specimens in each morph group for each geographical zone.

Geographical zones	Proportion and percentage in each morphology group* [with months of capture]		
	Morph 1 (pale)	Morph 2 (intermediate)	Morph 3 (dark)
A: Gladstone to Cooktown	36/49 73.5% [iii-vii, x-xii]	10/49 18.4% [i, iii, v, xii]	4/49 8.1% [xii, v]
B: Cooktown to Thursday I. group	33/74 44.6% [ii-viii]	38/74 51.4% [i-viii, xii]	3/74 4% [vi-viii]
C: Torres Strait N of Thursday I.	13/107 12.1% [i-ii, iv-v, vii]	41/107 38.3% [i-ii, iv-v, vii, ix]	53/107 49.6% [i-ii, iv-vi, ix]
D: Northern Territory, Western Australia	4/71 5.6% [i, iii, v]	23/71 32.5% [i-vi, xii]	44/71 61.9% [i-vii, xii]

\* The numbers of specimens of the rarer morph that were not considered for the study found in each geographical zone were: in Zone A - 4, B - 3, C - 4 and D - 6.

For all specimens examined there was no seasonal influence detected, that is no correlation between month of capture and any morphological category in any geographical zone. The size of the females examined varied within each morphological category and geographical zone (forewing lengths 14-20 mm). In summary, the review indicated that the upperside facies of female *H. p. phorbas* became progressively darker moving in a northerly direction through tropical Queensland and, in addition, specimens from the northern Torres Strait islands contained similar proportions of each morph group to the Northern Territory/Western Australia *H. p. ingura* specimens, and this trend was not related to seasons.

The review of the males from each geographical zone indicated that they had common features in all zones (Figs 9-24). In general, the uppersides were highly variable, particularly in the extent, shade and intensity of the coloured area, this colour varying from dark purple-blue through to aqua-green. The relative size of the sex brand and the extent of white scaling in the area above vein 1A+2A on the forewing, and the number of white subterminal rings on the upperside of the hind wing, were also variable. Moreover, dark purple-blue (Figs 9, 15, 19 and 23) and paler blue specimens (Figs 10, 13, 18 and 24), including specimens with white scaling in the area above vein 1A+2A of the forewing (Figs 9, 16, 20 and 22), occurred in all zones. Forewing lengths varied greatly (13-19 mm), as did the shape of the hind wings and, to a lesser extent, the forewings, but none of these features was related to any particular geographical zone. Four specimens were noteworthy in that they were

atypical of all other males examined (Appendix 2). These were: (i), Great Keppel Island, Qld, 25.xii.2002, JSB (JSBC) – very restricted upperside coloured areas, apical black ground colour of forewing meeting sex brand (forewing length 17 mm) (Fig 22); (ii), Mt White summit, Coen, Qld, 6.vii.1976, GBM (QM) – small with white scaling covering almost all the coloured areas of the forewings (14 mm); (iii), Sale R., WA, 16.v.1996, CGM (CGMC) – small with grey-blue upperside (12 mm); (iv), Yeppoon, Qld, 27.x.1924, GB (QM) – small with very dull blue upperside (13 mm).

## Discussion

*Hypolycaena phorbas* shares an obligate relationship with the weaver or green tree ant, *Oecophylla smaragdina* (Hymenoptera: Formicidae) (Eastwood and Fraser 1999) and, consequently, the two species' distributions are closely linked (Lokkers 1986, Shattuck and Barnett 2001, Braby 2000). Lokkers (1986) studied the distribution of *O. smaragdina* in Australia and his mapped data indicated that its distribution on mainland Australia closely matched the known distribution of *H. phorbas*. He also found the ant in the intervening gulf country region, between the Northern Territory and Queensland, where *H. phorbas* has not yet been recorded.

All females of *H. phorbas* have the same dull greyish-black upperside ground colour, but the extent of the central cream forewing patch, the amount of bluish-grey scales that overlie the patch and the number and intensity of the white subterminal rings on the hind wing vary greatly, even within the same geographical zone. Despite this variation, there were distinct trends observed which strongly indicates that female *H. phorbas* forms a cline in tropical Queensland, with typical 'pale' *H. p. phorbas* predominately occurring south of Cooktown, with mostly darker specimens recorded northwards to the southern Torres Strait islands, and with mainly very dark examples, typical of *H. p. ingura*, found in northern Torres Strait. This cline is likely to extend to southern coastal Papua New Guinea, where females also have the central cream-coloured patch on the forewing highly variable in size and with dark examples known from coastal towns opposite the northern Torres Strait islands (E.D. Edwards pers. comm.).

Although this cline is evident in Queensland because of the known continuous distribution of *H. phorbas*, from Tannum Sands to northern Torres Strait, there are no collection records for this species from the gulf country between the west coast of Cape York Peninsula in Queensland and East Arnhem Land in the Northern Territory. In this particular area *O. smaragdina* is known to occur (Lokkers 1986) and, considering the diverse habitats that *H. phorbas* occurs in, its wide host range and its obligate association with *O. smaragdina*, it is highly likely that *H. phorbas* has a continuous distribution from southern coastal Papua New Guinea across Torres Strait into Queensland, and from there through the gulf country to East Arnhem Land, Darwin and northern Western Australia. With the above

evidence, and the fact that examples from northern Torres Strait and the Northern Territory/Western Australia mostly fall into the same morph group, the status of subspecies *H. p. ingura* is tenuous. Therefore, it is proposed here that *H. p. ingura* Tindale be placed as a junior synonym (syn. n.) of *H. p. phorbas* (Fabricius).

The upperside facies of all male *H. phorbas* examined were highly variable, particularly in the upperside colour and in the presence of white scaling in the forewing area above vein 1A+2A. Males from the southern end of its range at Yeppoon, referred to by Braby (2000) as being darker and duller blue on the upperside, were also recognised from other locations, even in the extreme north of the range. As a result of this variability, no distinctive feature or collection of features could be assigned to any geographical zone and no progressive trends were detected. Overall, there was no evidence found to indicate that the variation observed in males was clinal.

Oddly, the distribution of *H. phorbas* in Torres Strait is poorly documented, with Braby (2000) offering only scant information on its distribution in this region, although he presented a useful map of the region showing all the island groups. Therefore, a summary of the current known distribution of *H. phorbas* in Torres Strait is documented here. All recent collection records since the 1970s indicate that it occurs on the Thursday Island group of islands (*i.e.* Thursday, Prince of Wales, Horn and Hammond) (CGM, RBL and S.J. Johnson [SJJ] collection records, De Baar 1988, Lambkin and Knight 1983), on Moa and Badu Islands (Valentine and Johnson 1993, CGM and AIK collection records), on the small, uninhabited islands of Suarji and Getullai immediately east of Moa (De Baar 1988), on Yorke and Yam Islands in the central eastern area of the strait (JWD and AIK collection records, respectively) and in the far north of the strait near the Papua New Guinea coastline on Saibai, Boigu and Dauan Islands (AIK, CEM, JFD, PSV, RPW, SJJ, SSB and TAL collection records). Interestingly, despite extensive collecting since the early 1980s on Darnley and Murray Islands in the far east of the strait, there are still no collection records of *H. phorbas* from these two islands aside from the early 20th century records of H. Elgner (Waterhouse and Lyell 1914). In addition, *H. phorbas* is not known from neighbouring Stephens Island. Interestingly, however, since the commencement of this collecting resurgence no *O. smaragdina* obligate butterfly species, nor the ant, have been collected on Murray Island, and only *Liphyra brassolis* Rothschild (Lycaenidae) (Johnson 1983), together with *O. smaragdina* (De Baar 1988), are known from Darnley Island.

### Acknowledgements

I thank the following for allowing examination of material held in their collections: J.S. Bartlett, S.S. Brown, M. De Baar, J.F. Donaldson (including the Department of Primary Industries and Fisheries Collection, Brisbane), E.D. Edwards (Australian National Insect Collection, Canberra), C.E. Meyer,



C.G. Miller, G.B. Monteith (Queensland Museum, Brisbane) and R.P. Weir. Appreciation is given to S.S. Brown, J.W. d'Apice, J.F. Donaldson, S.J. Johnson, A.I. Knight, R.B. Lachlan, C.E. Meyer, C.G. Miller, P.S. Valentine and R.P. Weir for providing collection records, and to E.D. Edwards for information on *H. p. phorbas* in southern Papua New Guinea. J.S. Bartlett gave valuable support in formatting and preparing the colour plates.

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## Appendix 1

Abbreviations of specimen depositories for Appendices 1-2 and Figures 1-24 are: ANIC – Australian National Insect Collection, Canberra; CEMC – C.E. Meyer Collection, Canberra; CGMC – C.G. Miller Collection, Lennox Head; DPIFC – Department of Primary Industries and Fisheries Collection, Brisbane; JFDC – J.F. Donaldson Collection, Thornlands; JSBC – J.S. Bartlett Collection, Brisbane;

MDBC – M. De Baar Collection, Brisbane; QM – Queensland Museum, Brisbane; RPWC – R.P. Weir Collection, Darwin; SSBC – S.S. Brown Collection, Bowral; TLIKC – Joint T.A. Lambkin and A.I. Knight Collections, Brisbane.

Abbreviations of collectors recorded in Appendices 1-2 and Figures 1-24 are: AIK – A.I. Knight; CEM – C.E. Meyer; CGM – C.G. Miller; DC – D. Cook; DLH – D.L. Hancock; DW – D. Wilson; DY – D. Yeates; GB – G. Barnard; GBM – G.B. Monteith; JCO – J.C. Olive; JFD – J.F. Donaldson; JSB – J.S. Bartlett; JWCD – J.W.C. d'Apice; LRR – L.R. Ring; MDB – M. De Baar; PRS – P.R. Samson; PSV – P.S. Valentine; PW – P. Wilson; RBL – R.B. Lachlan; RPW – R.P. Weir; SRM – S.R. Monteith; SSB – S.S. Brown; TAL – T.A. Lambkin; WG – W. Graham; WHM – W.H. Miskin.

*Collection data for 317 specimens of female H. phorbas examined and placed into four geographical zones*

ZONE A. QUEENSLAND: 2 ♀♀, Allingham, ex pupa, 10.iii.1982, 25.iii.1985, PW (DPIFC); 2 ♀♀, Annan River, Cooktown, 31.v.1998, CGM (CGMC); 7 ♀♀, Cairns, 26.xii.1966 (1), 2.iv.1968 (2), 16.iv.1969 (1), 7.v.1969 (1), 28.v.1974 (2), JWCD (ANIC); 2 ♀♀, Cairns, 12.xii.1963, 17.v.1971, CGM (CGMC); 1 ♀, Cape Tribulation, 19.iv.1969, JWCD (ANIC); 2 ♀♀, Cardwell, WHM (QM); 1 ♀, Cardwell, 21-23.xi.2004, MDB (MDBC); 1 ♀, Cooktown, 20.iv.1922, GB (QM); 1 ♀, Cooktown, 12.v.1992, JWCD (ANIC); 1 ♀, Cooktown, 7.v.1999, CGM (CGMC); 1 ♀, Crystal Ck, 41 km S of Ingham, 24.ii.2002, CGM (CGMC); 1 ♀, Ellis Beach, 3.xii.1964, CGM (CGMC); 1 ♀, Flying Fish Point, 24.iv.1987, AIK (TLIKC); 7 ♀♀, Gordonvale, 17.iv.1992 (1), 11.iv.1994 (1), 12.vi.1994 (2), 5.i.1995 (2), 8.vii.1998 (1), CEM (CEMC); 1 ♀, larva coll. Home Hill, 30.i.1986, PRS (DPIFC); 1 ♀, Lake Placid, Cairns, 21.xii.1963, CGM (CGMC); 1 ♀, Lucinda, 26.ii.2002, CGM (CGMC); 1 ♀, Port Douglas, 13.v.1973, CGM (CGMC); 1 ♀, larva coll. Port Douglas, 30.iv.1985, PRS (TLIKC); 1 ♀, S. of Port Douglas, 21.iii.1975, MDB (MDBC); 1 ♀, Saunders Beach, 17.iv.1992, LRR (CEMC); 1 ♀, same data except (RPWC); 3 ♀♀, Shute Harbour, 13.xii.1966 (2), 29.iii.1968 (1), JWCD (ANIC); 1 ♀, Townsville, 4.v.1983, AIK (TLIKC); 1 ♀, Townsville, 18.v.1983, SSB (SSBC); 2 ♀♀, Townsville, 10.v.1984, 20.xi.1984, PSV (TLIKC); 1 ♀, Trinity Beach, 20.v.1994, JCO (CEMC); 1 ♀, Trinity Park, 26.iv.1995, TAL (TLIKC); 1 ♀, West Hill Ck, 50 km S of Sarina, 11.xii.1983, MDB (MDBC); 2 ♀♀, Second Beh, Yarrabah Pen., 29.xi.2004, MDB (MDBC); 2 ♀♀, Yeppoon, 27.x.1924, 28.x.1924, GB (QM); 2 ♀♀, Yeppoon, 12.iii.1987, AIK (TLIKC).

ZONE B. QUEENSLAND: 1 ♀, Bamaga, 19-20.vi.1992, AIK (TLIKC); 3 ♀♀, Bamaga, 30.vii.1998 (2), 7.vii.1998 (1), CEM (CEMC); 1 ♀, 11 km S of Batavia Downs, 30.vi.1975, GBM (QM); 8 ♀♀, Cape York, 26.iv.1969 (1), 29.iv.1969 (1), 11.vi.1973 (3), 21.v.1974 (1), 7-13.iv.1977 (1), 22.v.1992 (1), JWCD (ANIC); 1 ♀, Cape York, 6.vi.1928, GB (QM); 1 ♀, Capsize Ck, 64 km N of Archer R., 17.vii.1975, GBM (QM); 3 ♀♀, 15 km W of Captain Billy Ck, 5-12.ii.1976, GBM (QM); 1 ♀, 43 km NW of Cooktown, 13.viii.1977, CGM (CGMC); 2 ♀♀, 23 km N of Cooktown, 27.iv.1999, 28.iv.1999, CGM (CGMC); 1 ♀, 26 km W of Fairview Station, Coen Rd, 24.vii.1977, CGM (CGMC); 1 ♀, Hibberd Pt, Weipa, 3-5.ii.1976, GBM (QM); 1 ♀, 7 km N of Hopevale, 18.vii.1975, GBM & SRM (QM); 1 ♀, Iron Range, 10.viii.2001, AIK (TLIKC); 2 ♀♀, Iron Range, 24.viii.1999, 10.vi.1982, CGM (CGMC); 1 ♀, Iron Range, 4-12.vii.1995, JWCD (ANIC); 1 ♀, Iron Range, 7.vii.1999, RPW (RPWC);

1 ♀, Kowanyama, 10.i.1977, DLH (QM); 1 ♀, Stock Ck, 15 km E of Kowanyama, 13.i.1977, DLH (QM); 3 ♀♀, Lockerbie, 23.iv.-1.v.2004, CEM (CEMC); 1 ♀, Lockerbie, 10.v.2003, SSB (SSBC); 1 ♀, 22 km N of Moreton, 2.vii.1975, GBM (QM); 1 ♀, Musgrave, 23.v.1998, CGM (CGMC); 1 ♀, Normanby River crossing, 12.v.1992, JWCD (ANIC); 1 ♀, Rocky Pt, Weipa, 3-5.ii.1976, GBM (QM); 1 ♀, Stewart R, 6 km W of Port Stewart, 19-20.vii.1975, GBM (QM); 6 ♀♀, Thursday Island, Torres Strait, 22.vii.1983 (1), 24.vii.1983 (2), 16-17.vi.1992 (1), 10.iv.2000 (1), 22.v.2001 (1), AIK (TLIKC); 17 ♀♀, Thursday I., 24-26.iii.2000 (2), 13.v.2001 (1), 24.iv.2001 (2), 4-5.v.2002 (1), 8.v.2002 (4), 9.v.2002 (1), 10.v.2002 (1), 13.v.2002 (1), 18.v.2002 (1), 20.v.2002 (1), 23.v.2002 (1), 26.v.2002 (1), CEM (CEMC); 2 ♀♀, Thursday I., 30.iii.-2.iv.1984, JWCD (ANIC); 3 ♀♀, Thursday I., 3-4.v.2002, RPW (RPWC); 3 ♀♀, Thursday I., v.2001, SSB (SSBC); 5 ♀♀, Thursday I., 23.vii.1983 (1), 12-15.iv.1992 (2), 12.xii.1993 (1), 25.iv.1995 (1), TAL (TLIKC).

ZONE C. QUEENSLAND (TORRES STRAIT): 1 ♀, airstrip, Badu Island, 11.vii.1977, CGM (CGMC); 5 ♀♀, Boigu Island, 8-9.iv.1992, AIK (TLIKC); 3 ♀♀, Boigu I., 8-9.iv.1992, TAL (TLIKC); 1 ♀, Boigu I., 12.iv.1992, TAL (MDBC); 21 ♀♀, Dauan Island, 2.iv.2001 (2), 4.iv.2001 (2), 14.iv.2001 (1), 21.iv.2001 (1), 30.iv.2001 (1), 2.v.2001 (2), 3.v.2001 (3), 13.v.2001 (1), 14.v.2001 (1), 27.i.2004 (1), 28.i.2004 (2), 29.i.2004 (3), 30.i.2004 (1), AIK (TLIKC); 36 ♀♀, Dauan I., 11-17.iv.2001 (28), 19.iv.2001 (1), 21.iv.2001 (1), 27.iv.2001 (1), 28.iv.-2.v.2002 (4), 1.v.2002 (1), CEM (CEMC); 6 ♀♀, Dauan I., 3-4.v.2002, RPW (RPWC); 2 ♀♀, Dauan I., 19.iv.2001, 25.v.2001, CEM (SSBC); 1 ♀, Dauan I., 26.iv.2002, SSB (SSBC); 6 ♀♀, Dauan I., 17.ii.2004 (1), 18.ii.2004 (1), 19.ii.2004 (1), 21.ii.2004 (3), TAL (TLIKC); 6 ♀♀, Eet Hill, Moa Island, 9-13.vii.1977 (4), 10.vii.1977 (1), 11.vii.1977 (1), CGM (CGMC); 3 ♀♀, St Pauls, Moa Island, 8.vii.1977, 14-17.vii.1977, 17.vii.1977, CGM (CGMC); 1 ♀, Moa Island, 27.v.1924, GB (QM); 3 ♀♀, Moa I., 9-13.vii.1977, GBM (QM); 1 ♀, Moa I., 4.i.1975, RBL (SSBC); 8 ♀♀, Saibai Island, 10.iv.2001 (1), 19.iv.2001 (1), 7.v.2001 (2), 8.v.2001 (1), 22.v.2001 (1), 5.ii.2004 (2), AIK (TLIKC); 1 ♀, Saibai I., 2.v.2002, SSB (SSBC); 3 ♀♀, Saibai I., 28.ix.1992 (2), 22.ii.1994 (1), TAL (TLIKC); 2 ♀♀, Yam Island, 18-20.vii.1977, GBM (QM); 1 ♀, Yam I., 11-12.vi.1992, AIK (TLIKC); 1 ♀, Yorke Island, 15.vi.1973, JWCD (ANIC).

ZONE D. NORTHERN TERRITORY: 1 ♀, 10 km E of Adelaide R., 16.iv.1995, CEM (SSBC); 2 ♀♀, Alyangula, 17-20.v.1982, 19-21.v.1982, JWCD (ANIC); 11 ♀♀, Berrimah Research Stn, 10-20.i.2003, RPW (RPWC); 3 ♀♀, Bustard Island, 21.v.1982, JWCD (ANIC); 3 ♀♀, same data except CGM (CGMC); 1 ♀, Channel Island, 2.iv.1995, CEM (CEMC); 1 ♀, Casuarina, 14.ii.1992, SSB (SSBC); 1 ♀, Darwin, 2.vii.1973, JWCD (ANIC); 1 ♀, Darwin, 6.ii.1987, CGM (CGMC); 3 ♀♀, Darwin, 20.iv.1991 (1), 8.ii.1992 (2), DW (RPWC); 10 ♀♀, Darwin, ex larva, 1-22.iii.2003, RPW (TLIKC); 4 ♀♀, Darwin, ex larva, 6-8.ii.2003, RPW (SSBC); 1 ♀, 130 km S of Darwin, 1.v.1989, RPW (RPWC); 1 ♀, Gunn Pt, 26.iv.1991, SSB (SSBC); 1 ♀, Ininowinyin Gorge, via Oenpelli, 20.iv.1922, GB (QM); 1 ♀, Kakadu, 25-26.v.1986, JWCD (ANIC); 5 ♀♀, Leanyer, 11.xii.1998 (1), 16.xii.1998 (1), 1.i.2000 (2), 10.iii.2003 (1), RPW (RPWC); 1 ♀, Marrakai Rd, 70 km S of Darwin, 29.iii.1992, DW (RPWC); 14 ♀♀, Palmerston, 2.iv.1995 (1), 16.iv.1995 (1), 18.iv.1995 (2), 19.iv.1995 (1), 22.iv.1995 (2), 23.iv.1995 (3), 26.iv.1995 (1), 28.iv.1995 (2), 25.v.1995 (1), CEM (CEMC); 1 ♀, Palmerston, 24.iv.1995, CEM (SSBC); 5 ♀♀, Palmerston, 14.ii.1992, SSB (SSBC); 1 ♀, Radon Ck, 14-16.vii.1979, GBM & DC (QM); 2 ♀♀, Wessel, 26.vi.1973 JWCD (ANIC).

WESTERN AUSTRALIA: 1 ♀, 37 km S of Kalumburu 3.vi.1990, CGM (CGMC); 1 ♀, Pascoe Island, West Kimberley, 30.v.1990 DY (QM).

## Appendix 2

### *Collection data for 123 specimens of male H. phorbas examined*

QUEENSLAND: 2 ♂♂, Allingham, 10.iii.1982, 25.iii.1985, PW (DPIFC); 4 ♂♂, Bamaga, 27.vii.1983, 19-20.vi.1992, 3-8.v.1994 (2), AIK (TЛИKC); 1 ♂, Bamaga, 15.iv.1995, TAL (TЛИKC); 2 ♂♂, Boigu I., Torres Strait, 8-9.iv.1992, AIK (TЛИKC); 1 ♂, same data except TAL (TЛИKC); 2 ♂♂, Cairns, 2.iv.1968, AD (ANIC); 4 ♂♂, Cairns, 16.iv.1969, 25.xii.1969, 5.x.1970, 1.xii.1971, AWH (ANIC); 1 ♂, Cairns, 28.v.1974, JWCD (ANIC); 3 ♂♂, Cape York, 29.iv.1969, 6.v.1969, 21.x.1979, JWCD (ANIC); 1 ♂, Daintree, 16.v.1988, AIK (TЛИKC); 14 ♂♂, Dauan I., Torres Strait, 1.iv.2001, 3.iv.2001, 4.iv.2001, 10.iv.2001, 14.iv.2001, 2.v.2001, 9.v.2001, 10.v.2001, 11.v.2001 (2), 14.v.2001, 16.i.2004, 28.i.2004, 29.i.2004, AIK (TЛИKC); 1 ♂, Dauan I., 4.iv.1990, JFD (JFDC); 23 ♂♂, Dauan I., 17.ii.2004 (3), 18.ii.2004 (3), 19.ii.2004 (2), 21.ii.2004 (15), TAL (TЛИKC); 1 ♂, same data except (JFDC); 3 ♂♂, Flinders I., 5.i.1973, JWCD (ANIC); 1 ♂, Great Keppel I., 25.xii.2002, JSB (JSBC); 3 ♂♂, Flying Fish Point, 25.iv.1982, 14.iv.1987, 21.iv.1987, AIK (TЛИKC); 1 ♂, Hull Heads, 27.iv.1978, TAL (DPIFC); 1 ♂, Iron Range, 26.v.-8.vi.1982, JWCD (ANIC); 2 ♂♂, Moa I., Torres Strait, 15.iv.2001, 16.iv.2001, AIK (TЛИKC); 1 ♂, Mt White summit, Coen, 6.vii.1976, GBM (QM); 3 ♂♂, Portland Roads, 19.xii.1966, 2.v.1969 (2), JWCD (ANIC); 3 ♂♂, Saibai I., Torres Strait, 28.ix.1992 (2), 14.iii.2001, TAL (TЛИKC); 6 ♂♂, Saibai I., 10.iv.2001, 6.v.2001 (2), 7.v.2001, 15.ii.2004 (2), AIK (TЛИKC); 1 ♂, Shute Harbour, 1.i.1967, RD (ANIC); 1 ♂, Thursday I., vii.1983, AIK (TЛИKC); 2 ♂♂, Thursday I., 23-31.vii.1983, 12-15.iv.1992, TAL (TЛИKC); 7 ♂♂, Thursday I., 22.vi.1973 (5), 2.iv.1984 (2), JWCD (ANIC); 4 ♂♂, Townsville, 20.xi.1984, PSV (TЛИKC); 3 ♂♂, Yeppoon, 27.x.1924, GB (QM); 1 ♂, Yeppoon, 3-4.i.1979, TAL (DPIFC); 1 ♂, Yeppoon, 12.v.1995, AIK (TЛИKC); 1 ♂, Yorke I., Torres Strait, 16.vi.1973, JWCD (ANIC); 1 ♂, Yule Pt, 30.iv.1978, TAL (DPIFC).

NORTHERN TERRITORY: 1 ♂, Bustard I., 21.v.1982 JWCD (ANIC); 3 ♂♂, Darwin, v.1983, WG (DPIFC); 6 ♂♂, Darwin, larva collected, 1-22.iii.2003, RPW (TЛИKC); 1 ♂, Darwin, 18-28.v.1986, JWCD (ANIC); 1 ♂, East Point, Darwin, 28.iv.1993, AIK (TЛИKC); 1 ♂, Point Stuart, 6.vii.1973, JWCD (ANIC); 1 ♂, Robin Falls, 3.vii.1973, JWCD (ANIC); 1 ♂, Rocky Bay, 3-7.v.1992, JWCD (ANIC); 2 ♂♂, Cape Wessel, 26.vi.1973, JWCD (ANIC).

WESTERN AUSTRALIA: 1 ♂, Kalumburu, 13.v.1991, JWCD (ANIC); 1 ♂, 37 km S of Kalumburu, 12.v.1991, CGM (CGMC); 1 ♂, Sale R., 16.v.1996, CGM (CGMC).